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ABSTRACT

A study looked at four groups of mostly senior graphic and industrial design students in their final semester capstone course--a collaborative studio project intended to give them the opportunity to apply their design expertise to real-world problems for real clients. The study examined the ways in which one of these groups used arguments to handle the developmental and communication-based difficulties of approaching an open-ended project. Data were collected through structured and semi-structured interviews, direct observations, and archived documents and drawings. The scenario called for the participants to design the next family of Apple computers; the largest computer was to be a desktop sort and the others hand-held or wearable. A vocabulary developed by the observation team proved helpful in evaluating the functioning of the student design team: requirements (features considered necessary for the proposed design); criteria (the norms that are necessary to fulfill the design requirements and the relative weight that should be given to each of these norms); models (prior designs that can serve as potential analogs to the current design); plans (which exist at the confluence of requirements, criteria and models); and prototypes (more costly than plans, they are refined enough to "work"). An examination of how one group worked through these various stages shows the enormous potential for conflict, frustration and confusion. Generally, however, the student group worked smoothly, especially after plans and prototypes were on the table. (TB)

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Collaborative Invention in Computer Prototype Design: Negotiating Group Processes and Artifacts

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Mark Werner
Conference on College Composition and Communication
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Introduction

Throughout this project described in these three papers, we have focused on the role of argument in collaborative efforts that routinely cross visual and verbal modalities. While David Fleming's paper told of the importance of considering the client 's requirements in design activity, and Ann Sinsheimer-Week's paper told of the importance of giving attention to the legal requirements in design situations, this paper seeks to describe how a group of designers employed arguments surrounding verbal and visual artifacts to respond to a complex and open-ended design problem.

Participants

My study looked at four groups of mostly senior graphic and industrial design students in their final semester capstone course—a collaborative studio project intended to give them the opportunity to apply their design expertise to real-world problems for real clients. All were graduating seniors or master's students who, with this rare opportunity for exposure and recognition in their field, were excited about the task. In all, I observed thirteen students and five professors.

The instructors assigned the class into four groups; initially two with four people, and two with three people. All teams had at least one graphic designer and one industrial designer, and some also had professional writers. My description in this paper will focus primarily on one group of four stu-

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dents (with two industrial designers and two graphic designers). However, I believe similar observations could be made about the other groups that I also watched throughout the semester.

Methodology

Data Collection

To collect data on the designers' use of argument in collaborative design problems, I used an observational methodology to limit the amount of intervention on my part and to collect a natural and rich record of design activity in the widest array of contexts possible. I used three methods to collect my data: structured and semi-structured interviews, direct observations, and archived documents and drawings.

Vocabulary for Analysis

To describe common rhetorical practices across the three projects described in this panel and to provide a framework for other researchers and practitioners who study designers to potentially test, modify, and use to explain loci of argument in collaborative design, my colleagues and I constructed a vocabulary of five terms—requirements, criteria, models, plans, and prototypes—by attempting to describe the loci of convergence or divergence of verbal and visual arguments common across our collaborative design projects. These terms also may be thought of as describing points of contention about which agreements and disagreements in design turn.

Requirements.

Requirements are the features considered necessary for a proposed design. External requirements are often set by the client—in my study, Apple Computer Corp.who had invited several top design schools to compete in a contest asking them to design the next family of Apple products. Because of the

contstraints of the contest, Apple only provided a one-time, one-way communication to the designers stating their requirements for the project. The designers also had other potential sources of requirements, their instructors—all having input to the final grades of the students. Since there were so many voices of clients in my study, the potential for discord about the perceived requirements for the project was strong. Indeed, the designers seemed at times to never know exactly who spoke most representatively for "the client."

In contrast to external requirements, designers' requirements are requirements held by members of the design team. In an obvious sense, the requirements of the designers must overlap with the external requirements of the client. But the mapping between the two sets of requirements is complex and subtle, often requiring that designers make inferences about their client.

Criteria.

Design criteria are the "norms" of proceeding that are necessary to fulfill the designers' requirements. Such norms are established from years of training and experience and often sound as innocuous and obvious as mom and apple pie: good design is simple, uniform, appealing, and so on. But such norms are only a small part of the contextualized knowledge needed to operate as a designer. Rules of application are usually hidden from the statement of norms; and, taken as single words, criteria can sound contradictory. For example, "surprise" may be a valued element of design, but equally valued may be "predictability." Attached to specific patterns in specific contexts, however, such criteria are not in fact contradictory; experienced designers can (so it seems) fill in the missing patterns and contexts needed to keep them from being contradictory.

Designers, then, may fail to meet a criterion not because they fail to believe in its worth, but because they fail to give it the priority it deserves.

Design criteria may be thought of as "top-down" points of instantiation. While giving the designer far less information than needed to finish the design, they nonetheless offer useful starting points from which to plan their design.

Models

Depending on their previous experience, designers can retrieve from their memories a catalog of prior designs that can serve as potential models or analogs to the current design. Designers may look to their memories for models, or as in the case of the Apple Computer project, they may supplement their memories with external research. Unlike criteria, which guide the design from the top down, models guide it from the bottom up. The advantage of models in directing a design is that models are complete; they leave nothing to the imagination about how the smallest detail is to be filled in. The disadvantage, however, is that because of the completeness of detail of one model, the model may not "transfer" to the new design problem. The model being "transferred" may have been designed under different requirements and with different criteria as priorities.

Plans

Plans exist at the confluence of requirements, criteria, models, and the context for the design. Plans go by many names: sketches, doodles, drawings, mock-ups, story boards, outlines. Plans are more concrete and visible than criteria and more flexible than design models. They provide useful points of focus against which members of the design team can check their potentially inchoate images of the design project with those of other members.

While plans are visible enough to command the undivided attention of everyone on the team. (that is, they can focus the cognition of individuals

onto a single visual field), they may also be produced by everyone on the team, and produced frequently. The introduction of a visual plan, in other words, may become a frequent enough non-event that the plan only achieves casual and uneven processing, given no more detailed and focused attention than the words the designers volley back and forth, which occurred in the early stages of the Computer Project.

Prototypes

Prototypes are plans that are refined enough to "work." They are thus more costly than plans, usually requiring the effort of multiple individuals. Prototypes, then, benefit convergence because they command the sustained focus of the entire team. Because of the cost of producing and attending to them, however, prototypes may have the effect of cutting off alternative design options, at least temporarily. Prototypes are also the first representation detailed enough to be evaluated from the user's perspective. Prototypes benefit convergence between the designers' requirements and external requirements.

Designers may role-play the user and imagine the user's experience with the product through scenario-based reasoning. As mismatches are discovered between the user's expectations and the actual functioning of the prototype, the prototype is revised to eliminate them.

Let me give you an example using all five terms. A requirement of the design was that "the computer should be interactive and pen-based." A criteria of the designers was that "keypads are not good unless you can feel them." An example of a model the students used was a pocket-sized notebook, which was used to model the size of the palm-top computer. An example of plans were sketches or doodles providing a few views of a palm-top computer. And finally, an example of a prototype was a foam block that was sculpted by the designers to look like a palm-top computer.

Having illustrated some key concepts to describe the collaborative argument employed in the group I observed, I will now describe for you how these key concepts describe the loci of collaborative argument in the design problem facing these designers.

Collaborative Argument in the Apple Computer Project

The designers in this study appeared to illustrate relatively successful example of collaborative design: an efficient transition from research to plan to prototype to final design. The ease of forward and productive movement which this group exhibited may be explained in part by the relative absence of the client and the open-ended nature of the task. In the rest of this paper, I will attempt to illustrate, using that vocabulary our research team has constructed, how even though their effort was for the most part successful and efficient, the group of designers faced a complex, relatively open-ended task assigned by a distant client who contacted them once and modified by the often contradictory interpretations of the instructors of the course.

In a letter inviting the designers to participate in their contest, Apple Computer company challenged them to design a family of computer products. They spelled out their requirements in this letter—the designers were asked to:

> prototype the interface designs and physical forms for at least three computers. Each computer device should have a different function but be able to work as a part of the same family of interconnected computers. The largest should be a traditional office computer (a desktop machine); the others should be hand-held, even wearable. The purpose of this project is to design a family of computers that have different functions but all work together with a consistent look and feel.

Winning designs would be featured in a leading design journal and their creators flown to Apple headquarters to present their work.

In the absence of a strong client presence, the instructors played an important role in representing project requirements. For example, they told students not to make their designs too bulky or heavy, to provide drawings of the inside of the machines, and to make the look and feel of the designs match their cost. But two additional requirements seemed contradictory. Students were alternately encouraged to create blue sky interfaces, ones that were unconstrained by present technology; and then to make sure their designs were feasible, grounded in current (or soon to be current) technology. This shifting of perspectives—this incompatibility or dissonance—was frustrating to the students. Often they would present their work to the professors and be criticized for not being creative enough, not blue sky enough. Later, they would return with more "creative" ideas, only to be asked if their designs could be constructed with existing technology.

Research Efforts

Early in the semester, the instructors urged the students in each team to select a design idea and conduct research in that area. As a result, the students spent most of their time in team meetings, discussing first their research and then their proposed designs. Early on, these discussions centered on Apple's external requirements. As work progressed, however, the students began proposing requirements and specifications of their own, such as:

- two of the computers should be portable, one smaller than the other;
- all features should be controlled by the screen, not outside buttons;
- the computers should be interactive and pen-based;
- the computers should share a name to show they are members of one family.

The fact that a requirement was proposed by a designer, however, did not make it a requirement for the whole group. In the beginning of the project especially, the designers would often suggest a requirement that would be

met only with silence, and the group would simply move on to another issue. At other times, as in the example shown, the requirement would be rejected outright, sometimes with the argumentative help of what we have called design criteria:

Jill: We could have a recessed keyboard.

Mary: I don't understand what you mean by recessed. Is it sort of like a telephone keypad?

Ned: Keypads are not good unless you can feel them.

As their work progressed, members of the group often argued about these verbal requirements. Without connections to a shared physical plan or prototype, however, such discussions only minimally assisted ultimate convergence on specific ideas and objects.

The research that the instructors encouraged the students to conduct during the early weeks of the project was intended to acquaint them with state-of-the-art computer technology -- that is, with what we have called models. The designers were given topics and then asked to report back to the other designers in the class. This research phase lasted for the first five weeks of the four-month project. Toward the end of that phase, one instructor urged the designers to begin narrowing their design options by testing ideas against what would work out in the world. He asked them to focus on uses for the technologies they were developing, to define and solve real problems with those technologies. Another instructor urged the designers to role-play, entertaining hypothetical scenarios in which people actually used their technologies. In this phase, then, models were to be matched to the particular situation at hand.

current technology. For example, the designers developed a sketchbook idea, although they knew that the company was marketing just such a device.

In sum, then, whereas requirements often seemed to be the crux of group arguments, criteria seemed more likely to be shared statements that the designers used to establish a common background, a sense of collegiality, and consensus in the group.

Cycling through Plans and Prototypes

Once students had narrowed their ideas to one or two options, the instructors began to urge them to elaborate their ideas through sketching and writing, that is, through plans. But the initial efforts of the group to elaborate ideas were not through visual plans alone, but rather through a spiraling process in which they used plans—sketches, drawings, and lists, and their group discussions to help them to acquire the information necessary to achieve consensus and then to build more detailed physical prototypes.

Prototypes would then be evaluated in crits, after which the designers would go back to sketches, drawings and lists for the next series of refinements. The designers were adept at creating highly detailed sketches which helped propel the design forward. Physical prototypes were created several times in the project, but they were rarely "filled in." That is, at first they consisted only of foam block carved in some general shape. Gradually, the foam became more and more detailed. For the final presentation, the prototypes were encased in colored plastic and contained realistic-looking attributes such as screens and buttons. These models were costly to create in both time and effort.

Plans and prototypes served, then, to focus the efforts of the design team, providing them with a vehicle for debate about requirements and users. Such perceptually-shared artifacts, which instantiated a lexicon (terms, names, and

From Research into Plans and Protoypes

Design criteria can serve as filters in process of sorting out requirements. One source of criteria is the client, and the company in this case did provide the students with a list of criteria for success. According to that list, successful designs provide for:

- usability
- uniqueness
- feasibility
- communicability (that is, internally consistent and well presented)
- logical interpretations
- clarity of concept (though not necessarily detailed in implementation at this stage).

The instructors reinforced some of these criteria, especially:

- usability
- creativity
- feasibility
- communicability.

The designers, meanwhile, tended to emphasize:

- usability
- clarity
- comfort
- feasibility
- attractiveness
- communicability—that is, that form follow function, that the design be internally consistent, and that there be consensual justification for all decisions.

The designers rarely discussed creativity or uniqueness. In fact, they seemed to suffer in the end from too much effort to ground their designs in

descriptions) that had previously been unattached to actual objects (but which nonetheless helped prepare the group for those objects), helped in turn to make sense of the lexicon, pushing the group now to develop, simultaneously, both words (attached to things) and things (attached to words). Interestingly, though, as the design activity moved more and more toward prototypes, the group met less frequently. When students did meet, they did so in subgroups, one assigned to the physical model and the other to the computer interface.

Before the fairly rapid and successful spiraling between plans and prototypes that occurred in the final weeks of the project, the designers had been stuck at a point where they were not able to agree on the attributes of their design, and more fundamentally, what they meant when they spoke of particular concepts. Once a concrete plan was "on the table," however—a visual instantiation of requirements, criteria, and the features of unique situations—productive dialogue seemed to increase, and refinements were made. The designer who took it upon him- or herself to create a prototype, meanwhile, was usually given license to make design decisions that were never brought up in group discussions. For example, the hand-held computer was designed to have contour lines fitted to the human hand. When this decision was presented by one of the designers to the rest of the group, no objections were raised or questions asked.

With plans and prototypes, the language that the designers use became immediately (and often productively) mapped onto physical artifacts that all members could see. And, because the designers in that project spent almost half of their project in research and deliberation, they established a shared project space where later plans and prototypes made communal sense. Another interesting feature of that process is the necessity, once at the stage of plans and prototypes, of role-playing potential users of the artifact, so that the design becomes increasingly attached to real situations in the world.

The final design consisted of three computerized tools for designers. One was a small, pen-based, hand-held computer that was a little larger than the size of a palm-top computer. It was meant to be carried at all times and was used for sketching and idea generation. Another was a desktop computer, measuring two feet by three feet, and functioning as an electronic drafting table. Finally, there was a computerized projector for use in client presentations. The design did not win the competition, and, unfortunately, the students received no feedback from the client. They did, however, present their concepts and prototypes to their professors and the other design students.

Summary

In design collaborations of the kind I have reported here—complex projects involving multiple individuals, in tasks of considerable uncertainty, extending over several months, and requiring the application of expert knowledge to unique social situations—there is enormous potential for conflict, frustration, and confusion. I have presented here what I believe to be a description of one way designers might face the challenges of a relatively open-ended project with a multiple client voices, where the client's requirements were not fully negotiated until plans and prototypes were already on the table. Until then, the negotiation of requirements was largely a matter of adding one verbal artifact onto another or using one to exclude another.

Perhaps because they had an interdisciplinary and talented faculty at their disposal, or because the group of students was itself small and interdisciplinary, or because the client's approach to the project was open-ended and hands-off, this design effort seemed less problematic than the other projects examined in this panel. Shielded in some sense from external requirements and inter-group negotiations, these designers had a good opportunity to develop internal processes and products without interference from outside the team. That is, there were no alternatives here to what the group ultimately

produced. Still, I believe this project represents a successful balance between early research and group discussion (about requirements and criteria particularly)—primarily an affair of coordinating verbal articulations of the task across individuals—and later planning and prototyping that required a cycling between perceptually-shared and evolving objects and a set of evolving verbal accompaniments to those objects.